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THE
SECOND BOOK
OF THE
ART of METTALS,
Wherein is
Taught the Common Way
OF
REFINING SILVER
BY
QUICKSILVER;
WITH

Some New Rules added for the
better performance of the same.

Written in *Spanish* by *Albaro Alonso Barba*, Master of Art, born in the Town of *Lepe* in *Andaluzia*, and Curate of *St. Bernards* Parish in the Imperial City of *Potosi*, in the Kingdom of *Peru* in the *West-Indies*, in the Year, 1640.

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Jos: Banks



*The Second Book of the Art of
Mettals.*

C H A P. I.

*That no man ought to be employed to Re-
fine Mettals, but he that hath been ex-
amined and Licensed by Authority.*

THe abundance of Minerals,
wherewith God hath enriched
almost all the Provinces of
this new world (serving himself
thereof as a Medium, to other high
designs of his Divine Providence) hath
been so great, that it is scarce possible
to be believed. The Mountain and
Imperial City of *Potosi*, having already
A 2 yield

yielded, between four or five hundred Millions of Peeces of Eight, a quantity sufficient to make such another hill of Silver; it is hard to form a conception equal unto so exorbitant a heap of Riches; but the better to help our imagination therein, know that, if the ground were covered with Peeces of Eight, laid as close to one another, as is possible, they would take up the space of sixty Leagues square, allowing five and twenty Peeces of Eight to a *Vare of Spain* (a *Vare of Spain* is 33. *English* Inches) and five thousand Vares to a *Spanish* League. This glut of Riches, hath been the reason why they have not applyed the care that was requisite, to prevent loss and waste in the Refining of Oar, which speaking with moderation, hath been the loss of many Millions, both for want of giving it due Law, the nature, and difference whereof, they did not understand; and so proceeded by chance, and without good ground, neither knew they well, what quantity of Plate the Oar would yield. And lastly, they destroyed unnecessary-

necessarily abundance of Quicksilver, whereof hath been already consumed in this Imperial City, more than 234600 Quintals ; I know not whether this neglect speaks greatness of mind in the inhabitants of this Kingdom , that they despise to pick up Crums, which nevertheless were sufficient to satisfie the hunger of many Kingdoms of the other world ; or whether it condemns the carelessness of so wise and well governed a Commonwealth , that they have not used all possible means to put a stop to so unnecessary a Prodigality. The first and fundamental remedy whereof, is in my opinion, that the Mettals be Refined by one that understands the Art , and is Authorized thereunto by Publick License , after strict examination of his sufficiency , which is required before the admission unto divers callings in the Commonwealth, without comparison of much less importance than this is. The Masters of Refining Works have taken no Care at all in this matter , because how negligently soever they Refine their own Oar,

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they

they lose nothing , but have all the Silver, either in the Plates, or amongst the Dross ; and that which they Refine for others , yields more profit to these Refiners, the worse it is wrought, because more remains with them in the Dross ; but both these are ill reasons to proceed upon , because the making full profit of their own, must cost a double labor, and the ill Refining other mens, redounds to a Publick prejudice.

C H A P. II.

What quantities, and what kind of knowledge a Refiner ought to have.

IT is a very great Trust that is put into the Refiners, the whole Riches which this most prosperous Country produceth , being put into their hands without account , or any obligation of the quantity they are to return ; their word and honesty only , without reply, or appeal from their sentence, is the only security of the truth, of what the

Oar

Oar hath yeilded ; and it had need be a strong security, when the violent incitation of private interest is to deceive. He therefore that liveth continually amongst these occasions, had need be well furnished with the honor of a Christian, lest having his fingers perpetually kneading in the paste, a good deal do not stick unto them ; there ought to be a great deal of circumspection in chusing this Officer, for no mischief that hinders the Refining of Oar, or extravagant consumption, or loss of Quicksilver, can occasion so great prejudice as a Refiner of a wicked Conscience.

Neither yet is it alone sufficient, that his Manners be good, if he want the knowledge necessary to the Art of Refining. He ought to know all sorts of Mettals, their qualities and differences, which of them are most proper for Quicksilver, and which for Melting, if there be conveniency for it. He should know the diseases also that infect Mettals, and the way of clearing them; the accidents of Quicksilver, and the ordinary way

of Refining in great and in little ; and in no case let him be admitted for a Refiner , that doth not well understand how to make the lesser Ensay by the Fire, of Oar that is ground to powder, before the Mettal be incorporated together, that so he may know certainly how much Silver ought to be gotten out of that Oar ; and he should never give over making tryals , untill he hath obtained it. The want of this one care hath cost this Kingdom abundance of Mony , and is of great prejudice to it, even at this day ; two experiments whereof I shall relate, which have passed through my hands , that you may the better estimate the importance of this advice : A few years ago , when I lived in the Province of the *Lipes*, in a Parish which they call *Xanquegua*, a Miner had wrought a Vein , out of which he drew a quantity of very Rich Mettal, although he knew it not ; he ensayed it by Quicksilver, and found it to contain four or five Peeces of Eight the Quintal , and at that rate Refined it all by the great ; at length they de-
serted

serted the Mine for being of little profit : Afterwards an *Indian* carried me to the place, I found Mettal in the Moulds that were drawn out, and also in the Vein which had not been much wrought, I Ensayed it by the fire, and found it to contain 900 Peeces of Eight the Quintal, although by the ordinary way of Quicksilver it yeilded but four or five; I discovered this Vein to the Magistrates, calling it by the name of *Nuestra Senora de Begomia*; they built a Mill presently near it, and abundance of Miners flocked thereupon, and have gotten thence a great quantity of Silver.

In the Mountain of *Santa Juana*, out of the Mine of *Berenguela de Pacages*, they got a Mettal like unto *Soroche*s, which by the ordinary Ensay with Quicksilver, appeared scarce to have any Silver at all in it; whereupon the Miners utterly deserted it, untill a Priest a Friend of mine, sent me some peeces thereof unto *Oruro*, which I Ensayed, and found them to contain 60. Peeces of Eight the Quintal; by my advice he dug a
great

great quantity of that Mettal, being laughed at by the Neighbors whilest he was at work to so little purpose (as they thought) but afterwards much more envied by them for the great riches he had gotten.

C H A P. III.

Of the knowledge of Mettals, and the differences there are of them.

IT is almost impossible to teach those, that have not been acquainted with Mettals, how to know them by the sight, because there is so great diversity of them; that there is scarce any stone in one Mine, that resembles stones of the same Mettal in another Mine; no nor oftentimes of the same Mine it self. Nevertheless the Miners reduce these differences unto three general heads, which the *Spaniards* call, 1. *Pacos*, 2. *Mulatos*, and 3. *Negrillos*. *Paco* in the general language of this Country, is as much as to say of a Red colour,
and

and such more or less are the Stones, which they call *Metal Paco*, although in *Berenguela de Pacages*, they call the Green Mettals of Copper by the same name, which also in these Provinces they give to Mettal of any colour, in contra-distinction to Mettals, that shine like Steel or Glas, and another sort which they call *Negrillos*. *Mulatos* is a colour between the *Pacos* and *Negrillos*; and in the Mines, Mettal of that colour is produced in the same order; it is of a Brown colour, and ordinarily accompanied with some of the *Margagita*; there is less of this Mettal, than of the two other sorts. The *Negrillos* have been discovered by, and take their name from their colour, although all Black Mettals are not comprehended under that name. *La Tacana* a rich Mettal, and usually Black, although there be of it Grey and Ash-coloured, which they call *Lipta* belongs to the *Metals Pacos*, as also doth the Lead (for so they call the Silver Oar) which oftentimes is Black, Grey, Ash-coloured, Green, White, and Orange Tawny, which they

they call *Suco* ; and this last year in the Mountain of *Potosi*, there was found of it, of a bright lively Cinamon colour, or very fine Vermilion , a thing which hath not been seen in any other Mine. The *Soroches* might constitute a fourth order of Mettals, but I agree with the opinion of others , that would have them ranked under the name of *Negrillos* , to which also belongs the *Rosicler*, the richest Mettal that nature hath produced in the form of a Stone ; it is shining and brittle, and the powder of it beaten finer with any hard thing, is of the colour of pure blood , it is very like unto *Cinabrio* , or that Vermilion which is made of Quicksilver and Sulphur , which gives a good hint for the finding out of divers other greater secrets. *Cochico* is also of the same kind a very rich Mettal Massy, but neither so brittle nor spungy as the *Rosicler* is, but it is more full of Lead, and is not so easily beaten to powder, nor gives so perfect a blood colour.

Soroches, *Tacana*, *Poluorilla*, *Rosicler*, *Cochico*, and *Negrillos*, are distinguished
one

one from another, in the manner following.

The *Soroche*s are black, or Ash-coloured, either shining, or without any lustre (which they call dead Oar of Lead) and commonly contains some Silver.

The *Tacana* is Silver Oar close compacted, of a Black colour, without any shining at all.

Polvorilla is *Tacana*; not congealed, nor stony, but is rich in that Oar they call *Pacos*, but in the *Negrillos* not so much, by reason of the mixture of Copper, that it hath.

The *Rosicler* and *Cochico* is Silver Oar with that same Varnish, which hides its own proper colour, and shines, whereby it differs from the *Tacana*. That which predominates in the *Negrillos*, is Copper, either actual, or else Vertual in the Copperas, wherewith it abounds; it always contains Silver more or less, and is usually accompanied with the *Margagita*.

The Black Mettal which feels like Lead, and is smooth (which makes as it were

were Leaves of Trees or Feathers) contains a great deal of *Alcohol*, or *Antimony* (which in some parts they call *Macacote*) and but little Silver. Those *Negrillos* which have lustre like polished Steel, or Looking-glass, and are therefore called *Espejado* and *Acerado*, are the richer the nearer they approach unto the *Rosicler* and *Cochico*.

C H A P. IV.

Of the sorting of Oar, and the proper manner of Refining each of them.

THe skill of extracting all the Silver, out of any Oar, begins to be exercised in the picking and sorting of the Oar together; the want of care in sorting Oar from Stones, that have no Oar in them, as also the Oar of one sort of Mettal from another, hath occasioned much damage; the least inconvenience hath been in the use of Quicksilver, a quantity whereof is lost together with grinding, and other charges about that which is no Mettal; the greater inconveni-

venience hath been, where there was Mettal, the failing to get out all the Silver, because they have jumbled together Oar of several sorts, and used but one manner of Refining, whereas those Mettals require a different way of handling and time. To Ensay that Mettal by Quicksilver, that requires the fire, is to destroy it; to put that Mettal in the Furnace, which is not to run, is to endamage the Mettal, and to get no profit at all; and although the several Oars be properly assigned, some to the Quicksilver, and some to the fire, yet they have their differences of being easier or harder to be Refined according as they concur, or differ in the remedy, that is necessary to be used for that purpose. The Oar, which they call *Pacos*, that shines or sparkles not at all, is proper for Quicksilver. The *Tacana* also may be refined by Quicksilver, but because it is so very rich Oar, lest it should not be clean extracted, but part of it remain in the Dross, it is better to melt it in a bath of Lead. That Oar which containing Silver in it, yet they

they call by the name of Lead Oar, if it be over gross, will neither grind well, nor cleave fast to the Quicksilver, and is best to be melted together with the *Tacana*.

The most proper way of dealing with the Oar, they call *Machacado*, is the Hammer, the *Soroches* need the fire, the *Rosocler* and *Cochico* are to be melted like the *Tacana*; the *Negrillos* require both fire and Quicksilver, for they prepare all the Oare of that kind by the fire, for the Quicksilver by that means collecting the Silver, either burnt, or boyled, as shall be shewed hereafter.

CHAP. V.

How to know the ill qualities that infect the Oar, and how to purge them away.

OF various and very different qualities are the substances that Nature hath produced in the Veins, that contain the Oars of Mettals, whether they

they be Abortions which the covetousness of Mankind occasions by tearing the Oar out of the bowels of the Earth before its full time, which otherwise would come to be Mettal in perfection, or whether it be excrementious superfluities of the generation of all sorts of Mettals; they be usually called Semi-minerals and are Salts, Allum, Copperas, Sulphur, Orpiment, Sandaraca, Antimony, or Alcohol, Brimstone, both White and black, and Margagita.

Scarce any Oar is gotten that doth not participate of one or more of these ill companions, all of them being hindrances to the extracting Silver out of the Oar, whether it be by the Fire or Quicksilver; those that partake of Copperas, of which sort are those they call *Copaquiras*, are mortal enemies of Quicksilver, which they consume and scatter, and that ill condition is heightened, if Salt be mingled with it, which makes it penetrate more violently, and suddenly; the learned *Raimundus* knew this antipathy very well, and hath left it discovered to us in writing; and

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those

those that deal in Mettals daily have it in their hands , and yet take no notice of it ; this is that, which eats up the Quicksilver, and dissipates the Caxomes of Mettal, and hath occasioned so great an expence of Mettals, namely, Iron, Lead, Tinn, and Lime. Whosoever hath a mind to make experiment hereof, let him mix a little Quicksilver with Copperas well ground, and water, and he shall see in an instant all the Quicksilver dissolved and lost ; especially if he put a little Salt to the former composition. This will be no wonder to those that know *Mercury* to be Quicksilver, and that the great change in its substance, is caused by Copperas and Salt, wherewith it is mingled, and then sublimated in the heat of the Fire ; this is the greatest poyson to the refination by Quicksilver ; although sometimes it is useful, and serves like Treacle to those sorts of Oar, which have use of it, as shall be shewed in it's place hereafter.

This inconvenience is found out, and remedied, with very much ease ; grind
a lit-

it a little Oar, and put some fair water to
 ce it, heat it the more the better, stir it
 he well, and then let it stand a while, then
 es pour out the clear water into another
 at vessel, leaving the Sedement behind
 n, undisturbed, prove it by the taste, and
 er you shall well judge what mixture it
 e-hath, by it's dry or soure taste; and
 th whosoever desires an occular demon-
 nd stration of this, let him set the afore-
 k-said water upon a gentle Fire, simmer-
 ifing untill the moysture be consumed,
 m-and he shall see with his eyes; in that
 to which remains at the bottom, either Al-
 k-lum or Copperas. Bathe the Oar in the
 its manner abovesaid, so often as shall be
 nd necessary, untill the water, that comes
 en from it be sweet, and without taste, or
 his that stirring it with a bright peece of
 on Iron, it doth not stain it with the colour
 s it of Copper, and then that Oar is per-
 to fectly cleansed and secure, not to hurt
 of the Quicksilver, when it is put unto
 re-it.

Although Sulphur, Betun, and Anti-
 nd mony do oftentimes discover them-
 nd selves unto the sight, yet a better way
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of finding them out, is by the smell, which comes from the Oar, when it is well burnt in the Fire; but for fuller satisfaction herein, they may be discovered and cleared from the Oar in the manner following.

Grind the Oar somewhat gross, and put it in an earthen Pipkin that is not glazed, that hath a great many small holes in the bottom of it, and stop the mouth of it close, then fit a Vessel of water round about it, in such manner as they do, when they clear the Pine Apples from Quicksilver, and put fire under the same Basen of Water, wherein all the smoak that goes out of those little holes will settle, and there you shall see congeal'd and swimming upon the top of the Water, the Sulphur, Antimony or Betun, each in his proper form. When the Oar will smoak no longer, it is a certain sign that it is clear of those impediments, which although they be not direct enemies to Quicksilver in raw Oar, yet the Varnish which they give to the silver, hinders the Quicksilver from laying hold of it, and uniting it

it together; and by the brittleness and a perity like Glass which those Oars have that participate of the impediments aforesaid, they cut and divide the Quicksilver when they are stirred together into small White pins heads as it were, which the *Spaniards* call *Lis*. It is necessary to burn this sort of Oar, although it be good to melt them first before they put them into the fierce Fire, because without that preparation the Silver will all be turn'd into dross.

The *Margagita* that is in Oar, discovers it self but too plainly to the eye by its weight and sharp glassie quality, it divides the Quicksilver into small *Lis* when they stir them together, those ill qualities are taken away by the Fire, if you burnt it therein untill its gloss and shining be gone, it doth most hurt unto that Oar vvhich they melt, the abundance of Sulphur vvhwhereof it is compounded making a great scum upon the face of the Liquor, vvhich much stiflenth the fundition.

C H A P. VI.

Of the Grinding of the Oars of Mettal.

THe Grinding of Oar is a preparation absolutely necessary for the getting out of it, the Silver, or Gold that it contains by Quicksilver, and the fineness of the Meal is a principal means of shortening the work and clear extraction of the Plate, one fault amongst many, which the blockishness of this Country has committed, hath been to make the meal very gross, or to leave many lumps therein; there needs no great pains to prove that the Quicksilver attracts or incorporates with it self that Silver which it immediately touches; so that the Mettal which is in middle of any lump remains in the same condition it came out of the Mine, and has more or less loss in it, according to the richness of the Original Oar, and according to the richness or coarseness of the Meal. I have made divers tryals of Grinding those lumps over again, and
find

find that in them remains, when left the sixth part of what is in the Oar when it is first taken out of the Mine, which is very considerable in a whole years work, and incredible in the great quantity of Mettals that have been already gotten. *Agricola* after having taught the way of Grinding & sifting of Mettals which they now practise in the Mills, teaches a way how to reduce it to extraordinary fine Flower in a kind of horse Mill with Stones like Mill-stones : he thought this pains to be necessary, although to an end different from that refining which we now practise, wherein it is clearly and indispenseably necessary. I learn't the manner of doing this from one that had gotten a great deal of mony by Grinding the lumps over again, although he did not take out all the Plate, because he ground them in an ordinary Mill, whose Hammers could not beat it so small as it ought to be, for the lumps either slip'd away from under the Hammer, or being uneven one defended the other from the stroke; to have good Sives, and care

in lifting them up is of great importance to this matter , but not a full remedy , after the washing of the Oar, especially if it were of rich Mettal is the best gathering up of lumps to regrind, If they burn the lumps, they will yield more Flour, because some of the lumps will calcine and be smother, and others will swell and grow more spungy, whereby the blow of the Hammer will have better effect upon them. I do use another way of preparation by boyling, as shall be shewed hereafter, which I do hold more proper to be used in all refination by Quicksilver ; put the Oar ground and searsed into a Skillet in like manner (as if it were already incorporated with Quicksilver , and ready for washing) then pour a sufficient quantity of water upon it, stirring it with a Ladle or hand-mill, whereby all the fine will swim a top, and the gross and ill ground will sink to the bottom ; take away the fine with a ladle, put it in the melting pot and boyl it , grind the grosser part again in a Mill or a Morter untill it become all meal ; If I desire to
make

make a Xoves of the fine sort after the ordinary manner of refining, I must mingle some pure sand therewith, that it may swell and want the Inconveniencies which that kind of Oar useth to be accompanied withall.

CHAP. VII.

Touching the Burning of Oar.

THe Burning of Oar is useful for two purposes, *viz.* 1. That it may Grind the better. 2. That it may be in better disposition for the Quicksilver to lay hold of, and incorporate it self with the Silver that is in it. The reason of the first is plain, and the experience of the latter, since they order all the Negrillos or blacker Oar in that manner, but generally not understanding the reason thereof. And certainly in all the art of refining nothing is practised so much by guess or chance, and without knowing the ground of it, as this is. Refiners will say, they burn
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the Oar to clear it of ill qualities, not apprehending that thence it will follow that by fire enough they should quite cleanse and purifie it, whereas the contrary is found by experience, and that according as they burn it more, the worse conditioned is the Oar, and needs the help of some other material to prevent, that all the Silver and Quicksilver too, that is in it, be not lost.

There is but one enemy naturally opposite unto Quicksilver (as hath been said already) and that is the Copperas, and the fire is not only useless for the vanquishing that, but on the contrary it multiplies and encreases it; and if the Oar have no Copperas in it when it is put into the fire, the fire will beget and produce it, as may easily be seen by experiment. In the Burning of Negrillos (or black Oar) in which the fire encreases the Copperas so much, that it is necessary to use other materials in the burning of it to repair that damage, although if they had thoroughly understood this matter, they might
have

have cheaper and easier done it , by washing the Oar (as I have said before) untill it were cleared of all the Copperas ; The ignorance of which remedy hath been the occasion of great waste and loss.

Other diseases of Oar do not directly injure the Quicksilver, only by the Varnish and Glassie quality which they give ; they hinder the Plate and Quicksilver from incorporating and making a Mass together ; and therefore the rule in this case is to burn the Oar so long untill it change colour and lose the lustre and sparkling that it had. To know the Oar that of necessity must be burnt (if it be to be Refined by Quicksilver) the lustre and shining aforesaid is a certain sign. The fire will not prejudice that Oar they call Pacos , and if it have any mixture of the aforesaid impediments, it must of necessity be burnt.

C H A P. VIII.

*Touching the damage that results from
the burning of Oar.*

MEN having hitherto proceeded by chance as it were, and without certain knowledge of the quantity of Silver contained in a peece of Oar have judg'd him the best Refiner that has gotten most Silver by one operation, leaving it doubtful whether any more or no were to be gotten out of the Oar, especially in the Negrillos and Oars that cannot be excus'd from burning. This doubt has been greater, there being less certainty here where there ought to be much the greater ; and from hence men have found no less inconvenience by mistaking on the one hand, than on the other ; wherefore this manner of preparation hath been esteem'd, as dangerous as profitable. With skill and curiosity one may observe many wonders of Nature in the burning of Oar, the parts of Iron and Brimstone, which commonly

monly accompany the Oar , when they come to the fire are converted into Vitriol or Green Copperas; this afterwards is turned into fine Copper; again, the Copper calcined, dissolves in water like salt, the which strain'd and evaporated by a gentle heat coagulates into another kind of Vitriol or blew Copperas, like unto that which they call the stone *Lapis*, and is of admirable Virtue for the turning of almost all Mettals into Copper, the purity of Silver it self does not excuse it from being subject to such a metamorphosis, for if the Oar have in it any Allum, Copperas, Saltpeter, or Nitre by the help of the fire, they will calcine the Silver so , that it will dissolve in water , and not be lay'd hold on by Quicksilver without using some new Artifice , and even Salt alone as it grows incorporated in the Oar, or mingled with it in the fire is capable of producing the same effect as shall appear evidently in the following experiments.

CHAP.

C H A P. IX.

Experiments which prove the damage by the burning of Oar if they be not known and remedied.

GRind a peece of Oar that has Copper or Iron in it, and by the direction of the fifth Chapter of this Book, try if there be any Copperas in it, and if there be, clear the Oar of it by washing of it, and after it is dry burn it well, and put it into water again, and you shall see much Copperas anew produced by the fire; the Refiners daily do this with their hands, although they take no notice of it; and although this experiment be sufficient to satisfy every body, yet for greater confirmation of this secret to grind Oar of Copper or Iron, and melt it into thin Plates, and grind some Sulphur, and in a Crucible or Earthen pot unglaz'd, put a lare of that Sulphur, and upon that lay one of the Plates, and proceed in that order as far as you think fit, stop
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the mouth of it well , that it give no vent ; and after it is dry, put it between red hot Coals in such manner as they encompass it round about , but do not touch it ; after the Crucible is sufficiently hot, put the fire neerer to it, and at last make the fire fierce, but not so much as to melt the Plates ; then take it out and the Plates will look black and be brittle , grind them very fine, and put the fourth part of their weight of beaten Sulphur, together with them into a peece of broken pot or earthen Bason upon Embers, heat them so as you heat an Ensay of the black Oar, stirring them continually untill the Sulphur have left smoaking, and the oftener you repeat this the better ; last of all being well beaten and hot, or else the water hot, and after a little time boyl the water, and if it colours bright Iron of a Copper colour , that the water evaporate by a gentle fire, untill it begins to be covered with a kind of Cream, then take it off and set it a cooling, and it will congeal into most beautiful transparent Copperras , Green if the Plates
were

were of Iron, or blew if the Plates were of Copper.

Dissolve this Copperas or Stone *Lipis* in water, and put Steel or Iron to it, and it turns into most pure Copper, smooth, and soft as gold after it is new melted. If one melt Lead or Tin, and pour it in small drops upon the face of that water, the whole superficies will be turned into Copper, and the oftner it is repeated, the greater quantity of the Lead will be transformed untill no Lead remain.

Tin is very easily turned into brass. I was the first which in the Province of the *Lipis* found out and published these secrets. Also Silver is turn'd into Copper if it be made very fine, and with much Salt (an experiment which ought to be as highly esteemed by the Refiners, as the turning Copper into Silver) *Aqua fortis* is a common thing, if it were not, its vertue would be held miraculous, it turns Silver into Water, and calcines it into dust; it is made of Copperas or Allum and Salt-peter, the Spirits that flye from any of these substances, when
Oar

Oar that contains them is cast into the furnace, works the same effects, with beaten Brick and Salt especially of the rock is made a Cement, wherewith they separate Silver from Gold ; these two attract the Silver to themselves and with the heat of the fire only calcine it; in the burning of Oar they have the same effect; the Silver being calcin'd in either of the aforesaid manner if it be put into water dissolves in it like Salt, and the Water looks white as milk, and will spot ones hands or nails if you touch it, notable signs of *Aqua fortis* in Silver, whereunto Refiners ought to have great regard, that it destroy not their Silver ; these inconveniencies there are in the burning of Mettals, besides another which anon shall be discovered, and though the proper way of avoiding them is casting or melting the Oar which renders useful, not only that Mettal which is precious, but also the baser sort, as shall be shewn in its place, nevertheless because all places do not afford conveniencies for melting down Oar, nor all Oars contain

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Mettals

Mettals rich enough to pay the cost, let the aforefaid inconveniencies when they happen be remedy'd according to the rules which shall be set down hereafter, although it be impossible to prepare Oar without burning so as to yeild that quantity of Plate it did by Quicksilver, as shall be shewn where the refination by boyling is treated of.

CHAP. X.

Whether the Oar ought to be burnt in the Stone or in the Meal.

They use to burn Oar in the Stone or in the Meal, and burning it in the Meal, they better understand the nature of the Oar, for taking care to stir it well about, and mix it equally in the Furnace, taking out a small quantity, and putting Quicksilver and Salt thereunto in a short space of time; by the disposition of the Quicksilver you shall quickly know what the Oar is, whether it begin to grow like Lead or
no,

no, and whether the Lead be gross or fine, or whether there be need of more materials or no, or whether to continue, or stop the burning of it, according as every Refiner by his own experience hath found to succeed best with it out of that Oar which is burnt in the stone, cannot be chosen this equality, because the force of the fire cannot be equally communicated to stones in a divers situation and of different bigness; for it is clear that the small stones are sooner hett than the greater, and those that are in the Center of the Furnace, sooner than those that touch the sides; but this manner of burning is subject to least damage, besides that it facilitates the grinding of the Oar.

It is a great error to burn Oar already grownd by reverberation, because the fierceness of the fire; burn the Sulphur or Betun which it contains, and suffer it not to discharge it self by little and little, but obligeth it to mingle it self with the Silver, and altogether to turn it into dross; moreover the force of the flame raises up the settled parts of the

Silver when they stir the Oar, and turning it into smoak, blows it out of the Furnace. The most secure way of burning Oar already grownd, is to do it by a Tostadillo (or preserving Pan) made in the fashion of a Furnace , as shall be directed hereafter, and because the Meal is wont by the fire to gather into little lumps, or else to grow spungy and gross , it is convenient to grind it over again, before it be incorporated, the best way of all as has been said were to burn it in the stone , because it facilitates and saves a great part of the grinding, and avoids the inconvenience of the fine Silver flying away in the smoak, and where the Oar is incorporated in hard Peble and Flint , which are very untractable stones, it is necessary to burn them. Other sorts of Oar ought not to be burnt alone , but in Meal with the mixture which shall be prescribed according to the ill qualities wherewith they are affected.

C H A P. XI.

Of Materials to be mixed with Oar, when they burn it.

IT is no extraordinary, but a common thing for Iron to be engendered in the Gold and Silver Oar, and the Oar, that is so affected, is most difficult for burning or fundition either; it may be discovered by the slowness of the heat's penetration into it, and also by a Loadstone, passing it over the Oar, after it is well burnt, and grownd, which will snatch up the Iron, if there be any, and more or less of it, according to the quantity mixt with the Oar. This kind of Oar after it is grownd, ought to be mixed with Sulphur, or which is better with the Meal of Oar that hath Sulphur, or Antimony in it, and in such proportion as the quantity of Iron in the Oar requires, when they are mingled, heat them upon the Tostadillo untill that taking out some of the Meal, and Ensayng it according to custome;

the Oar is found to be well conditioned. Sulphur is the destruction of all Mettals, gold only excepted; it hurts Tin less than other Mettals, and Iron most of all, and that is the reason why the Sulphur, and Iron combating with, and destroying each other in the Furnace, the Silver is left alone by its self. Inlike manner is Oar cured, that contains Sulphur or Antimony, being mingled and burnt with the Oar, or dross of Iron after it is well grownd.

That Oar which contains Orpiment, or Sandaraca, ought to be burnt with Soroches, which is Oar of Lead and Sulphur; that which contains Betun black or white must be burnt with dross of Iron, and powder of white stones, whereof they make Lime: Besides what hath been already said, the diseases of Oar may be known by putting a little of it grownd somewhat gross upon a red hote plate of Iron, observing well what fume it makes, which if it be white or black, participates of Betunes of that Colour, if it were yellow of Orpiment, if red of Sandaraca, if it be yellow in
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the middle, and green of the out sides, of Sulphur, and likewise the earth that is drawn out of the Mines, together with the Oar, will oftentimes send forth fumes of the like kind of colours.

CHAP. XII.

What the Refiner must do before he incorporates the Caxon.

THe Refiner thoroughly understanding what has been said before, the Oar being well grown'd & ceased with that curiosity and circumspection which is necessary (so that it need not be picked) Before he doth go about to incorporate the Caxon, and before he burns the Meal, if there were need thereof, let him set apart three or four pound of the Flower well mingled, and stirring it together again afresh, take a small quantity, & make two Ensayes thereof by melting in such manner, as shall be shewed hereafter; whereby he shall certainly know what Silver the Caxon contains, and how much he may expect to get out

of it. Laying down this ground, that the Oar is of that they call *Pacos*, and needs not burning, nor contains *Copperas*, nor *Coppaquiras*, take out some in the manner abovesaid, and Ensay a pound of it by Quicksilver, but first pour upon the Oar a good deal of fair water, more than is ordinarily necessary, and let it stand a while, and if there arise a scum, or cream, that is gross, or oily, scum it off, and let that water run out, and repeat the same with fresh water, so often, untill no such scum arise, then take out so much water as is superfluous, and put Salt and Quicksilver to it, and without any other material proceed in repeating, to cast in those too, marking well the operation of the Quicksilver, whether by accident it meets with more Quicksilver; whether it turns little or much to Lead, whether it dissolve or remain intire; if it fastens upon the Oar without the help of any Material, it is a sign, that the Oar doth attract it, to it self, repeat the operation so, untill you find that the force of the Silyer, and the repetition doth wast
the

the Quicksilver, which if it do the work is excellent, and will produce the Silver in dust as small as Pin-dust, which must be gotten together by sifting, and the remainder which is mingled with Quicksilver must be gotten by washing, and so you shall have all that the Oar contained, agreeable to the experiment, which was made by melting. The Oar of *Berenguela de Pacages* is of the quality afore mentioned, a great deal whereof was spoiled at first, by working it with materials, supposing it impossible there should be Oar, which did not stand in need thereof; now a-days they Refine with only Salt and Quicksilver, and get the same quantity of Silver, as they did by melting, which is all that the Oar contains; this Oar is called *Cobrico*, if the Ensay doth shew Lead, for so they call it, when the Quicksilver loses its own bright colour, and looks like Lead, then other materials are requisite to cleanse it, that it may the better take hold of, and gather the Silver together; those materials that have this virtue are Iron dissolved,

solved, Lead or Tin, and Lime slacked, or unslacked for some resemblance it hath to Mettal; any Oar may be Refin'd with the help of any one of these materials, although that seems to be best, which is nearest of kindred to the mixture of the Oar. If the dust of the Silver and colour of the Quicksilver be dusky and blackish, then Iron is most proper for it, for that which looks like Lead, Lead it self is best to that which is clear; Tin is the best for Quicksilver that looks as if it were guilt and hath Copper in it; Lime is the best this material which is most convenient they throw in by a little and a little at a time by measure and weight, untill the Quicksilver look clear, and lay hold on the Silver, and by this they make the account by the great, how much materials they are to put into a Caxon or Chest, according to the number of Kintals it contains.

If the Quicksilver be changed into white powder or Ashes, and often passing it again through the Oar, do not make it finer, it proceeds from the
weight

weight and solidity of the Oar, the proper accidents of those they call Soroches and Magagitaes, and those other Oars that sparkle and have need of burning, as have been said before. Hard stones that have no Silver in them cause the same accidents in Quicksilver, wherefore looking upon it reduced to white powder as aforesaid, if you do not discern either black Oar or Margagita amongst it, there was no Silver contained in that Oar which was Ensaied, and is good for nothing.

If in the lesser Ensay the Quicksilver be bright and entire, and falls to work, laying hold on the Silver, there is no need of using any other material, all Ensayes are made with a very little Quicksilver, that there may be room to use any other materials, if there be occasion for it, if not that more Quicksilver may be added, and so the work of Refining is perform'd with greater brevity and security, as shall be shewed hereafter; and let not the Refiner cease making experiments, untill the lesser Ensay which he makes by Quicksilver,

cor-

correspond with that which he make by melting, and let him proceed respectively in the greater Refining of the Caxones.

C H A P. XIII.

Continuing the Rules of the last Chapter, touching Oar that has need of burning.

IF the Oar have need of burning, as hath been said before, and the Ensay by melting made, and the Refiner assured of the quantity of Plate the Oar contains, let him burn it, observing the rules of what he is to mix with it according to the bigness of the work, and the convenience he hath to perform it in, but in no case let him burn any Oar with Salt; besides that it helps to calcine the Silver, it gives a stronger force to those ill fumes which are in the Oar to penetrate into and spoil the Silver. One cannot well tell the set number of hours, wherein one ought to let Oar
con-

continue in the fire , but the sure rule to know when the Oar is well condition'd , is by Ensayng some of the burnt Meal ; when if the Quicksilver remain intire and clear ; and Silver sticking about it like driven Snow , then it is burnt enough , and the fire continued , will certainly produce this effect if the Oar be mingled with due materials , and in a just quantity in order to which , as also in the Oars they call Pacos , let them make lesser Ensayns to know what quantity of Materials are to be put into the Furnace with every Kintal of Oar , but because these Ensayns are seldom made as they should be , let the following rules be observed.

When the Oar in the Furnace leave smelling ill , it is a sign that it has discharged it self of all the Sulphur and Antimony that is in it ; when that Oar charged with Betun , and at the first coming into the Furnace , throwing out a thick and black smoak by degrees , sends forth a thinner and whiter fume ; it shews that inconvenience to be cured.

When

When Oar changes colour, losing the sparkling that it had, and of *Negrillo* becoming *Paco*, 'tis a certain sign that it is well disposed for the Quicksilver, although in this there be exceeding great latitude.

That Oar which contains Copperas, if it be to be put in the fire, must first be cleansed by washing in Meal, as hath been said, otherwise when it comes in the Furnace, it will become very red as may be seen if one burn Copperas alone in the fire.

When Enfaying a little of the Meal burnt, the Quicksilver begins to look like Lead, it is a sign that by the heat of the fire the Copper or Iron which the Mettal contains (together with the mixture of Sulphur) the Antimony or Margagita are turning into Copperas, and that the faster, the longer the fire continues.

Take a pound of the Meal out of the Furnace, whilst it is hot put it into a Vessel, and pour water upon it three or four fingers deep, then stir it a while and let it settle, then if the water turn
white,

white, or stain ones Nails, or change the colour of the Taggs of points put thereinto, it is a sign that the Silver calcineth and dissolves in the water like Salt; save this water in a glass vessel, and pour more upon the Oar two or three times, or as often as is necessary, till it do not turn white; and all the Silver that was calcined, will be gotten out of the Oar; let the water evaporate by a gentle fire, and all the Plate will settle in the bottom, and become fit for use by melting.

If the water into which the hot Oar was put, give no signs of the Silver being calcin'd, dip polished Iron into it, and if it come out coloured like Copper, there is much Copperas in the Mettal; wherefore wash the Mettal in the manner as hath been taught, untill it be cleared of the Copperas, and and change not the colour of Iron; save the waters of this operation, for they are very useful in the Refining Oar that have need of it, and if you should take out and melt the Sedement that is in the bottom of that water, fine
Copper

Copper will be produced thereby, or Silver if any such have been calcin'd.

Ensay the Oar so disposed in little by Quicksilver, as hath been said of the Oars Pacos, untill by experience you have found out the way how to Refine in greater quantity, so that you may get as much Silver as you know that Oar contains by Ensayes of melting in the fire. Let no body condemn these for tedious and unnecessary curiosities, for there is nothing more profitable and important in these matters, nor less commonly known; & by the care & pains of a few days the Refiner will be acquainted with the sorts and qualities of Oar that come to his hand, and know how to proceed with them without wearying himself with making Ensayes; but for all that have been said, the Oar never comes to be perfectly Refined, untill the Silver little or much that it contained be purified and whitened in the Meal, and it is not impossible to put it in that estate. Since the Oares Pacos of Lead may be reduced thereunto only
by

by burning , and the Negrillos and others also that have Sulphur in them which stains and blackes the Silver, although it must be a long time in the fire before it comes to this , and both one sort of Oar, & the other must have boylings and liquors often passed through them , which do cleanse and whiten the Silver, such as Millo, Allum, Salt and others, the Oar being in this condition, needs no other material but Quicksilver, which in less than four days time will gather together all the Silver, and be very little consumed it self, because the short time of operation, the absence of ill qualities and the seldom times repassing it through the Oar, will not regrind, or disperse it to powder, which is the principal reason of the loss of Quicksilver, as shall be shewed hereafter.

C H A P. XIV.

Of the nature of Quick-silver.

DEferring untill another occasion, which it may be in due time will offer it self to treat purposely of Quick-silver, and some excrements thereof, of no less profit than curiosity for the present, I shall only say with that Phænix of Science in his intellectual Art, which all do follow, who treat of the hidden Philosophy of Mettals; that Nature hath made this body of so uniform a substance, and of parts so perfectly united, that even the fire his greatest enemy, as the vulgar think, is not powerful enough by dividing to corrupt, and destroy it as it visibly doth all other Mettals and bodies in the world, except Gold and Silver. The Quicksilver retains its whole intire substance in the fire, if it be prepared on purpose for it, which many persons know how to do, or else all of it will flye quite away in the form of smoak, and meeting with
any

any body that refreshes it ; it will condense therein in its own proper form without being diminished one hair, either in weight or quantity ; neither also do the ill qualities that are ordinarily found in Oar corrupt Quicksilver in Veins wherein it is begotten, nor in the Chests wherein they refine , for although Copperas do dissolve it in that manner that it seems to be consumed, and being sublimated in Copperas, and common Salt, it is transformed and turned into that which we call *Mercury*, that one would think it were totally destroy'd and turned into another species, yet it is not so , but all those accidents have their remedies , and it is neither impossible nor very difficult to quicken it again, and unite it , and in its place I shall shew how this is to be done.

C H A P. XV.

*Touching the causes and differences, of
that which is called Lis.*

Quicksilver dissolved, and divided into very subtile parts, is commonly called by the Refiners *Lis*, which shews its self like an eye-brow, in the matter *Purunnia* when the Oar is Ensayed; and from it the experienced Refiners take their indication of the quality of the Oar and condition of the Caxomes; it is caused by the often passing of it through the Oar (a thing inexcusable in the ordinary way of refining) although it hath no ill quality at all, but if it hath Copperas in it, it will grind the Quicksilver in great extremity, as hath been said. If Quicksilver be without any foraign impression upon it, and be dissolved into *Lis*, which is white, 'tis called *Lis* of Quicksilver, *Lis* of other materials, is called that which is made by Quicksilver of Tin or Lead, and *Lis* of Silver is the fine, and subtile

subtile parts of Silver, made by the re-
passing of the Quicksilver through the
Oar, but not as yet joyned or incorpor-
ated with it; which when it is, they
call by the name of *Pella* (which signi-
fies a Ball or Pellet) Quicksilver is
susceptible of divers colours, which ap-
pears in the *Lives* according to the dif-
ferent matter which accompanies that
Silver Oar into which it is thrown;
these colours are reduced into three
Genus's as it were, which comprehend
under them several other Species

Those three are } *Cleer.*
 } *Lead Coloured.*
 } *Spotted.*

The Quicksilver looks cleer, either
when the Oar hath no Silver at all in it,
or when the Silver it contains is fine
without any Alloy or mixture; in that
case the Quicksilver will attract, and
cloath it self with the dust of fine Silver,
without losing the liveliness of its co-
lor; which when it changeth, they call
it Leaden, for its likeness unto the co-
lour

-lour of that Mettal, although it always
 is accompanied with signs that the Oar
 contains Silver, unless it be that the
 Lead, for so they call it, proceed from
 false principles, and those have a mani-
 fest cause, although little taken notice
 of, as well as the other proceedings in
 Refining, which hitherunto have been
 governed by chance. It is Copperas
 alone (the mortal enemy of Quickfil-
 ver) which gives it the false colour of
 Lead, in like manner as it doth to other
 Mettals the colour of Copper; the o-
 ther Lead colour is a certain sign of Sil-
 ver, because ordinarily it is made in
 raw Oar, that is mixed with divers
 other bad things, the which attracting
 to it self the Quicksilver; the Quick-
 silver lays hold of, and carries away
 both the Mettal, and also its bad com-
 panions, who give it that strange co-
 lour; this is the ground of what is trea-
 ted of in the twelfth Chapter of this
 Book, and the reason of that assertion,
 that the black or obscure *Lis*, or colour
 of Quicksilver proceeds from Oar that
 is mixed with Iron; if the Quicksilver
 have

have a deep Lead colour, then it hath Lead its self in its company, if it be something more clear, then it hath Tin, and if it look as if it were guilt a little, Copper. Whether the *Lis* be of Quicksilver, Silver, or of other materials is easie to be discerned, for the *Lis* of Quicksilver is very fine, white, but wanting quickness, and when it falls together with the water into the Tray, it doth not run up and down, but remains as if it stuck to the bottom, and if rub it with your finger, it will unite into lumps of Quicksilver. The *Lis* of Silver shines, is like Pindust, or finer according to the richness of the Oar, when they let the water out from the Oar, it runs about the bottom of the Tray, and if you rub it with your finger, it will gather together into Pellets; the *Lis* of other materials is as it were a middle thing between the other two, and being reduced into a body by rubbing it with ones finger, it unites itself with the touched Quicksilver.

C H A P. XVI.

Whether it be fitting at first to put in all the Quick-silver, and other materials at once or no.

THE Oar being in good disposition, and the Refiner by the foregoing rules being assured how much Silver the Caxon contains, and what proportion of Quicksilver and other Materials is necessary to be put in, that when it comes to be washed, it may yeild three parts of Silver Pellets, and one of Quicksilver, it may be doubted whether all the Quicksilver and materials aforesaid, should be put into the incorporating vessel at once, or no; and the most part, if not all the Artists of this Country did use to do it at once; untill about twenty years ago, when I came to live in the Province of the *Lipes*, I perswaded them to the contrary according to rules, which I had learnt in such like operations, out of *Raimundus Lullus*, which do evidently agree with

with the ordinary course of Nature, that brings to perfection all things by a slow and gentle growth, and not suddenly nor violently. A very little fire is sufficient to burn the whole world, if the combustible matter were put into it by little and little, proportionable to the force of the fire; but if all that matter, or an over-great proportion of it should be laid upon the fire at once, it would choak it, and put it out: the natural heat of Animals is subject to the same inconvenience, and the same happens proportionally unto the Chests of Metals, besides that by experience it is found, that the extraordinary cold of much Quicksilver, doth accidentally bind up the Oar, and hinder the Refine, as on the contrary any heat hastens it; moreover if because they have judged ill of the remedy to be put into the Chest, the Caxon despair, and the Quicksilver dissolve, the remedy will be the easier, the less loose the Caxon. And if there be need of using Tin or Lead, which cannot be applyed without Quicksilver, that will be added
with

with less danger, the Quicksilver being in already. The same damage or greater follows when they exceed in the quantity of Materials, they put into the Oar which hath need thereof, because it dulls and deadens the Quicksilver, so that it will lay hold on no Silver at all, and can very hardly ever be reduced into that condition it ought to be. After many days spent in repassing the Quicksilver, and dressing of the Oar, let the Caxon be incorporated and washed with a third part of Quicksilver at the most, and at first put in half the Tin or Lead, that is requisite to be spent, for so the Quicksilver will the better lay hold of the Plate, and draw it out presently before the Materials are consumed, which they call *Aplomar*, whereby will be avoided the danger of the dry Plate, which like froath swims upon the water that comes out, and is the occasion of much mischief. If the Caxon stand in need thereof, proceed to put in more Quicksilver, and other Materials, always diminishing the quantities proportionally in such manner,

manner, that it may go dry and not wet, for so there will be no occasion for much *Lis*, and the Pellets themselves will serve to get out the rest of the Silver, whereby the refining will be soonest and most securely performed; if it be needful to Refine with Lime, the rule already prescribed for Materials will not serve, but the Lime must be put in all at once, and with it repass the Caxon very well two or three days before you put in the Quicksilver, taking especial care that you do not put in too much of it, because it is the great hinderance that the Quicksilver doth not lay hold of the greater Plate, and it is more hard to correct than other materials.

C H A P. XVII.

Of the often repassing the Quick-silver through the Oar and the effects thereof.

THe chief and principal end of letting it soak through, is to divide the
the

the Quicksilver into several bodies, that it may every where lay hold of the Plate , also with that motion it is heat, and better disposed for the work ; and last of all by that frication the Plate is cleansed and purified (which is that they call wasting the Materials) all of them, things most necessary and important, although they cause an unpardonable damage, that hath been the loss of many Millions in the wasting and consumption of Quicksilver, for the repassings have been the foundation of this inconvenience, by squeezing the Quicksilver through the grosser and finer parts of the Meal into such little Atomes (which they call *Lis*) that scarce have weight or dimension, which when they wash, the Caxon doth not fall down into the Tub at the bottom, but being over-drowned and mingled with the Lamas or mud of the Meal, it stays and is cast away with them ; this inconvenience may be prevented by two cautions , the one is, that the first and second day after the incorporating of the Meal of Oar in the Caxon, they give not
above

above two gentle repassings, so that the Quicksilver may be divided, but not into two small parcels, because before it hath gotten a good body of Silver, it is subject to part it self over finely. The second is as abovesaid, that they put in the other materials dry, and not wetted with Quicksilver, putting them in by little and little when most it be in the proportion, one part of Quicksilver to two of Pellets. Let no body deceive themselves, that although the Meal in the Caxon contain other Materials sufficient, if it be much bathed with Quicksilver that it shall be secured from the former inconvenience; for contrariwise it will rather be subject to a greater prejudice, for of necessity the repassings will make *Lis*, and if it happen by some accident as it very well may, that the Materials be quite consumed instead of the *Lis* made of them will remain only *Lis* of Quicksilver. In the *Lis* of Plate there is not that danger, that by the often repassings the Silver should be wasted or consumed, rather it is thereby better refined, and better embra-

ceth and uniteth it self with the Quick-silver.

C H A P. XVIII.

Of divers accidents, which happen in the way of Refining by Quick-silver, and their remedies.

IN the progress of this kind of Refining, divers accidents are met with all in the Caxones (or chest full of Oar grownd to be Refined) all which are discovered only by the Quicksilver, which as in a glass represents the good or ill disposition of the Mettal, which in themselves by reason of the fineness of the Meal into which they are grownd, and a mixture of earth in the Oar, cannot be discerned.

If the Quicksilver be very much charged above what it ought with materials, that is to say, Lead, Tin, Iron, or Lime (which the *spaniards* call Quicksilver Tocado) it will not appear round but flatted, or rather prolonged
like

like little Worms , and if you stir it about the Tray without water, it will make drops with little tailes, and stick to the sides of the Tray ; and when it is of this condition it is a sign that it is killed , and its virtue obstructed from laying hold of the Silver ; this evil is remedied by much repassing , not without great cost and expence of time ; the quickest and most efficacious remedy is Copperas, or the water thereof, which I have shewed how to make and to keep in the 13. Chapter of this Book, put it into the Caxones at the same time as you do the Quicksilver , and other Refining Materials more or less, according as there is occasion, and you shall instantly see the effect of it ; the reason whereof is plain, for (as hath been said) Copperas dissolved in water converts the baser Mettals into true Copper ; so that the quality of cold which they had before, and wherewith they choaked the Quicksilver , being turned into heat (the property of Copper) it is the cause of reviving the Quicksilver : From hence is grounded the

the practice of putting Copper grownd small into the Caxon, which is found very profitable for the purpose afore-said; hence also it comes to pass, that not all Oar of Copper although it be rich is not proper to clear Quicksilver with, or to be used in the Refining to make it Aplomar, unless it have a great deal of Verdigrease or Copperas. The same account may be given of the Virtue that is found in those they call Magistrates, which they use in the Refining to qualifie the Caxones with heat, and to make them Aplomar, the which effect is produced from the burnt Copperas that is in it, as may be seen in their composition, which for better satisfaction I shall here set down.

Burn Oar or Copper, and grind it well, then with an equal quantity of Salt knead it into a body together, and having made it into loaves burn it again.

Others do mingle but one part of Salt, with two parts of Copper Oar, which they make up into a body and burn, and to one Kintall of that beaten
to

to powder, they add half a pound of filings of Latin.

Another Magistral is made of Lamas.

Relabes and Salt, an equal portion of either soundly burnt together.

Another is made of that Oar where-with they Refine the Relabes and Salt put together in equal portions.

Another sort may be made of Copper Oar, Relabes, Meal of that Oar which is to be Refined, dross of Iron and Salt, all put together in equal portions and burnt in loaves.

Another is made of three parts of the Lamas burnt, and one part of Salt. Every one inventing such like compositions or proportions, according to his own fantasie, and experience: the foundation of all these Magistrales being the Copperas which the fire produces in them, as may be seen and separated from them, by whosoever shall please to go about it according to the rules that have been already delivered, which seems to confirm that which *Pliny* says,

E

trea-

treating of Copper, namely that it is begotten of stones burnt.

These Magistrales are to be used with the same carefulness as hath been already said of the materials, namely they are to be made tryal of before the incorporating of the Caxon, that by these lesser Ensayes it may be known what proportion is fit to be put into the Caxon, according to the number of Kintals it shall contain, for if the proportion do exceed, another great inconvenience will be produced thereby, namely that which follows.

C H A P. XIX.

In prosecution of the Chapter foregoing.

AN Accident contrary to that mentioned in the former Chapter, and an occasion of great waste of Quick-silver, is of the colour of Lead, that is to say, when it is affected with no other mate-

material of inconvenience, but only that discolouration, and the damage is the greater, if the discolouring hath proceeded from Copperas, and that there be much Quicksilver divided, and running loose about. Quicksilver squeezed out of the lumps is very round and lively; if it be divided, the parts of it, although never so small, do not run into a Cylindrical figure, but into a Spherical, this mischief is cured by the contrary materials, which as hath been said before cleave unto the Quicksilver, nevertheless the Medicine, which by its particular qualities, attraction, and natural sympathy cure this evil is Iron, which reunites the Quicksilver, and gathers it together into a body after it was dissolved, corrupted, and in a manner turned into another substance by the Copperas, which shall be treated of more at large hereafter, when we speak of washing the Caxones.

No certain rule can be given, what quantity of materials to put into the Caxones, that have failed in the operation, because the mischief and the causes

thereof are not always the same, but this general rule must be observed, that they do not repass the Caxon with Quicksilver, till they have first Ensayed a small quantity thereof, and thereby have understood what is necessary. After that let them take a third or a fourth part of the Caxon, and mingle that with the whole proportion of the Materials, and stir it well together, till it be very well mixed, and incorporated one with another, then mix this with the rest of the Caxon, stir them very well together, for after this manner the Medicine will be best, and with most equality distributed in the Caxon, especially if the Medicine to be put in be very small in quantity. Have a care to use the means, that is requisite to avoid falling into the first inconvenience of overcharging the Quicksilver, and remedy the second mischief with all possible speed, because otherwise the Copperas will transform the Quicksilver in such manner, as if it were quite eaten up and consumed. When Ensayng the Caxon the Quicksilver

silver is found in the bottom of the *Purrumia* Vessel divide it in small grains not run together in a lump, it is a sign the Refination is imperfect, and that some little hairyness, or crisping encompasseth the Pellets of Quicksilver, and hinders them uniting; the want of materials is commonly the cause of this, or else the over-much allay of other Metals, which as well as the Plate attracts the Quicksilver it self. Repasses, the Relabillo burnt by reason of it's sharp cutting quality is profitable to cleanse the Quicksilver: some put in ashes, but the most proper and natural remedy for it, is, that which they call Millo or Allum, which makes the Silver white, and is very ordinarily to be had in great abundance amongst the Mines here at *Potosi*, and in *Guaico de Santiago* there is a Spring that runs continually with this Allum water.

When the Caxon hath not been repassed equally, or not served with as much Quicksilver as is necessary, or in some places doth not unite it self with other parts of the Quicksilver, that had

gotten Plate already , the cause thereof is that they call dry Plate : In Enſays you ſhall ſee it ſwim upon the Relabes criſped like froth, and if it be not ſcimed off, and ſaved before the cleaning the Caxon, it will ſwim at the top, and run away with the Lamas to the great detriment of him that owes the Oar ; if the Quickſilver dry, having nevertheless materials ſufficient with it , it is no inconvenience at all , becauſe it will unite one with another the better, or elſe that part which the material poſſeſſed being waſted way, the other moiſt parts remain in the Quickſilver to unite it ſelf with the reſt of the Pellets ; that dry Plate which wants materials, cannot ſafely be gathered together by looſe Quickſilver , untill the Caxon be ready for cleaning ; the proper remedy for this is to repaſs the Caxon with Pellet of Silver , not over ſmall, ſo ſhall the dry Plate be collected together, and the greateſt part of the *Lis* alſo , if there were any there.

C H A P. XX.

How to know whether or no the Caxon be ready for washing.

THere can no certain time be prefixed, wherein one is obliged to wash the Caxones. It's maturity is hastened by frequent repassings by the outward heat of the Air, and the inward heat of the Copper or Copperas, and other things of that kind of virtue, and such as clear and purifie the Silver; a principal cause whereof is the burning of Mettals. On the contrary, the work of Refining is prolonged and slackened by fewer repassings, if the Air be cold or Frost, if the Caxon be over foul, that the Quicksilver loses it's clearness in passing through, but letting pass these, and other accidents, let us come to the point of gathering out the clear Silver mixed with Quicksilver, leaving the earth behind, which is called washing the Caxon, whereunto no small experience is necessary, for if the

Caxon be not ripe for washing, that plate which the Quicksilver hath not laid hold on, is likely to be utterly lost, or if it be not, it must be grownd over again, so that at least one loses much time and labour, and Silver too in the repassings, besides other hazzards.

The rules hitherto delivered for the discovery of the disposition of the Caxon are subject to very great error: such as it's appearing so well to sight as if there were need of no more Quicksilver; to find the *Lis* of the Plate all gathered together and finished, and that of the Quicksilver beginning to come; the substance of the Plate, and Quicksilver being clear, and gilded as it were with other signs, all of which do not secure the judgment from being erroneous, because these may be produced by other accidents besides the maturity of the Caxon. The only sure and infallible sign is to see whether the Quicksilver hath gotten all the Plate, which it ought to do according to the proportion shewed by the lesser Ensay of fire, which was made at the beginning, and if it
hath

hath not arrived to that, although it hath many more good signs than hath been already mentioned; wash not the Caxon, but take more small Ensayes thereof, whereby you shall easily prove what Plate it contains, and what remedy is necessary to bring it to full perfection, which when it is attained, and the refined substance alone contains the aforesaid proportion of Quicksilver and Pellet, strow some Quicksilver loose upon it, and therewith gently repass it two or three times in such manner as it may go into the Copper better bathed, in the proportion of three parts Pellet, and two of Quicksilver, or at least two of Pellet and one of Quicksilver; then gather up some of the *Lis* that remains, and put it to the dry Plate, and to the whole Mass of Pellet, whereby they will be more weighty, and sink better to the bottom of the Caldron, and will rise and wast less in the boyling; throw Quicksilver also loose into the Caldron (which they call a Bath (when it begins to be liquid, incorporate therewith that which the Caxon contained, and it will

will help to unite it the better, and the more Quicksilver there was, the fewer inequalities like Oyster shells will be produced.

CH A P. XXI.

That the washing of the Caxones causeth the loss and waste of Quick-silver.

ALL the inconveniences that are and have been found in the waste of Quicksilver, which they term either loss or consumption of it, are caused by the washing the Caxons; until then nothing hath been lost, however one may be deceived in Judging by the view even in occasions, that have sometimes happened and may happen again, that they find neither Quicksilver nor Pellet of incorporated Mettal in the Caxon; for accidents alone as hath been said, cannot alter the Quicksilver so as to corrupt and destroy its substance; in the Caxon it is howsoever more or less disposed to get out inperceptibly with the

the water or with the Lamas. The immediate cause of this mischief is when the Quicksilver is made over thin without body or weight as it were, so that it hath nothing to sink it to the bottom of the Caldron, and with the stirring the Caxon when they wash it, it mixeth it self with the dreggs and durt, and goes along with them, and there wants more or less of the Quicksilver they put in at first, according to their better or worse stirring the Caxon and quantity of *Lis*. It hath been a great error in those, that because for so many years the best Refiners in these Kingdomes have wasted at the least so much Quicksilver, as they have gotten Plate, therefore the Quicksilver is really and truly consumed in the operation, not animadverting the evidence to the contrary, which continually passeth through their hands, namely in the Lamas and relics of the Caxon where the Quicksilver hath oftentimes staved behind, accompanied with a considerable quantity of Plate, which the owners of Oar have experimented to their great damage,
and

and the buyers and Refiners of the relicks of the Caxon to their great profit and advantage. Others speaking Philosophically say, the cause of the consumption of the Quicksilver proceeds from the contention and combat, which it hath with contrary qualities before it can lay hold on the Plate, and that thereby it is debilitated and consumed; these men say something to the purpose if they could demonstrate the contrary qualities that are between Quicksilver and other Mettals, between whom there is rather a great sympathy & agreement, Quicksilver being the principal whereof all other Mettals are made, and also of the Minerals that ordinarily do accompany them, but if these men cannot prove the cause, neither will the effect which they suppose, namely the destruction of Quicksilver follow, and there is certain experience to the contrary, and hereafter shall be shewed a way how to recover all the Quicksilver, even out of the Caxon, that is most spoiled in operation, and so most difficult to do it in,

C H A P. XXII.

*The true causes of the loss of Quick-silver,
and their remedies.*

THe repassings are the remote cause of wasting of the Quicksilver, which is thereby strained and divided into very small parts which they call *Lis*, and although into whatsoever Oar, Earth or Sand you throw Quicksilver, and repass it, you shall find the effect aforesaid, yet it is most of all experimented in those Oars which are called *Soroches*, which by their weight and glassie quality, do more easily cut asunder, and divide the Quicksilver into minute parts.

Copperas is of its own nature a violent cause of extenuating the Quicksilver, as hath been often said, and hath been the cause of the wast of the greatest part of the Quicksilver that hath been destroyed. There be other causes, which accompany and assist the two former in working this ill effect, one is
the

the Salt, which they use in Refining, and wherewith they wash the Caxones, which every body knows thickens water, whereby not only the small *Lis* of Quicksilver, but also heavier things swim and cannot sink to the bottom.

The Lamas which is mingled with the water, and troubles it in the Caldron thickens it, and doth yet more resist the sinking of the Quicksilver which stays and is thrown away together with it.

Lastly, the motion of the instrument wherewith they stir the Caxon when they wash it by condensing the force of the causes aforesaid, hinders the *Lis* from sinking, and crowdeth it up to the top. The ordinary repassings in this way of Refining cannot be wholly excused in this matter, but if the rules already taught, be carefully observed, the damage will be the less: likewise already hath been shewed the way to clear Oar from the Copperas, and to clear the Margagitas from their heavy and glassie qualities. Salt may be gotten out of the Caxones two several ways, and pre-

preserved for use to the saving of many
 Ducats a year, now commonly spent in
 that commodity; put the Oar into
 Caxones made smooth and round on
 the inside without corners or Angles as
 is often used, let them stand a little
 sloping, only so much as is necessary,
 that all the water may run to one part
 of it, where there must be a hole for it
 to run out at in convenient season, but
 ordinarily kept stopped. When the
 Caxon is ready for washing, fill it with
 abundance of water, opening and stir-
 ring about the Oar with the hove, that
 the water may penetrate through it the
 better, and having done so a pretty
 while, open the hole, and let the water
 out into a Vessel provided on purpose
 to receive it, where it will either con-
 geal into Salt, or remain in liquor as it
 is, will be serviceable for the operati-
 on of other Caxones; repeat this two
 or three times untill the water that
 comes out doth not taste brackish.
 If the Caxon was to have been washed
 in three Caldrons wash it in six, where-
 by the water will come out twice as
 clear,

clear, and with very little Mud, or Sediment.

The Pestel wherewith they stir the Caxon, must not be used always in the same hand, because the circles going constantly paralel, the small parts of the Quicksilver, and the dry Plate go along together with them, and never encounter one another to unite themselves into a bigger body that they may sink to the bottom, wherefore after five or six turns with the right hand, take as many more of the left, and so proceed; and because this cannot so conveniently be done in the ordinary washing places, put into the Caldron a thing like a broad Peel, which opposite to the course and motion of the Pestel may disturbe the march of the Quicksilver and dry Plate, and cause all the content of the Vessel to meet and unite, excepting that which is at the bottom whereof there is no necessity, because of the bath which it is to suffer. Cover the Vessel with Plates of Copper, or Iron Quicksilvered, to which side soever of the Vessel the *Lix* comes, it may

may stick thereunto, when the Caxon is washed the *Lix* is easily gotten together, by sweeping the sides of the Vessel with a peece of shoo leather, a peece of a hat, or a peece of cloath.

C H A P. XXIII.

To make the Pine Apples, and to clear them of the Quick-silver.

HAVING taken the Plate and Quicksilver together out of the Caldron, and straining it through two course cloaths wetted, to make them the thicker, having beaten it also with a Battledoor to squeeze as much Quicksilver through the cloathes as is possible, make Pine Apples of the dry Pellets in moulds fitted for that purpose, which are called Pine Apples from their similitude to that fruit by reason of their Pyramidal figure, and

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of those Pines that have been reasonably well strained, the fifth part will be Silver, so that one Hundred pound of Pellets will produce twenty pound weight of Silver. The Pines that are made of richer Oar arise to less profit than those that are made of poorer, because the Plate in the richer Oar is more coarse and spongy, than that which is contained in the poorer. In the straining of the Quicksilver though never so carefully, some small parts of the Silver will go along with it, and the more in quantity by how much the more moisture there was in the Pellets when they began to strain them, the like whereof is seen in water mixed with clay, which although it be strained with never so much care, will not look clear and pure but muddy and troubled by reason of its mixture with the durt, and the great quantity of water there was, the more durt straines through along with it; letting it stand quietly a while it will settle and gather it self together, and leave the

the water clear. In like manner, in the Vessels wherein they preserve the Quicksilver after they have done refining, and made the Pine Apples, after a few days the Pellets of Silver will settle and gather into a body together in the refining work of Saint *Catherines* in the *Lipes* out of the Vessel, wherein they kept their Quicksilver, I saw as much Plate gotten of the kind aforesaid, as would have made a good great Pine Apple.

If the Quicksilver be heated it becomes thinner, and will carry away more Silver in the straining, also when the Pellets are strained, that are gotten by boyling although it be done with very much care, yet Plate will pass along with the Quicksilver, and if you will let it stand a days time to cool and settle, and strain it again, you will get more Pellets of Silver.

The loss in clearing the Oar again from the Quicksilver hath been great and irrecoverable, as may be guessed from the experiment thereof in this Imperial City at this present, when the Trading in Mettals runs but low, and yet *communibus annis* above thirty thousand peeces of Eight are wasted by the expence of Quicksilver, how vast a sum then hath been spent by Quicksilver in the many other very rich Mines belonging to this Kingdom; this inconvenience hath proceeded from want of care in seeing that the Canones and Caperucas (which are the names of the Vessels they use in the recovering the Quicksilver) be made of very good stuff, and shut curiously close in the place where they joyn together. The clay whereof usually they are made is very spongy and full of Pores, so that the water soaks through and sweats out at them; then it is no wonder that the Quicksilver attenuated by the violence of the fire (which widens the Pores
of

of the Vessel also) evaporates through the same , and is exhaled and lost : to say that any part of the Quicksilver is destroyed or perisheth by the heat of the fire is onely the imagination of those that understand not the uniformity of its substance, as hath been shewed before. Make the Caperucas and Canones of such stuff as you make the Crusiples, and that inconvenience will cease, and the Vessels will last for ever (because they are so mightily condensed and resist the fire) unless some accidental blow or knock do break them. In that noble Town of Saint *Phillipi of Austria, Oruro*, famous for abundance of Mines both of Gold and Silver, on the top of a little hill which stands above the Church of the *Ranqueria*, there is a little vein of white earth, whereof they make Vessels for use, which after they are baked become so close and firm that they are not inferior to the best *China*. I was the first that made try-

all, and published the usefulness of it for the making of Crucibles with very good success to those that had need of them, and I do not doubt but there is such kind of Earth about this City of *Potosi*, where nothing hath been found wanting that any wise belonged to the obtaining or refining of that abundance of riches, which nature hath bestowed upon it; although hitherunto much business, and a short time of abode here, hath hindered me from finding of it out. But where such kind of earth is wanting, mingle the Clay whereof you make these Vessels, the better with the scum or dross of Iron grownd very fine, and make it up and bake it very well, and there shall not be so much Quicksilver lost in the use of them as is, by those now in common use. The Canones must be glaz'd on the inside, the Caperucas not, because the violent heat will melt the glazing, and make it run.

C H A P. XXIV.

Other safer ways of clearing the Pine Apples from Quick-silver.

THe best Vessels for this purpose are made of Iron or Copper beaten to the thickness of a peece of Eight, or somewhat thinner, and for more security, that the Vessels may the better endure the fire, they cover the Copper Vessel with a coat of good earthen ware on the outside; not many years ago, some people began to use these Copper Vessels cased with earthen ware, and left them off again, because they understood not the nature of them, nor how to use them. The like happened in the Province of the *Chickas*, who cased their refining Vessels as abovesaid, because they heard that in their neighborhood in the *Lipes*, I was working after that

manner. The cause of these mistakes shall be shewed in the discourse which follows.

The shortest, best, and most secure way of clearing the Pine Apples from Quicksilver is in this manner; make a deep Vessel of Iron wider at the top than at the bottom, containing more or less according to the quantity of Mettal intended to be cleared at one time, set it upon a Trevet of strong Earthen ware, or of Iron cased with Earth in a Furnace of sufficient bigness to put Wood or Coals under it, as occasion shall require at a mouth made for that purpose; the rest of the Furnace both the top, bottom, and sides is to be very close; excepting one little hole at the top where it shall be found most convenient to give respiration; dispose the Vessel aforesaid in such manner as they do that which they call the Cannon in the ordinary way of using Quicksilver, so that it may look out above
the

the top of the Furnace one large fingers bredth or two, that it may the better joyn with another Vessel to be put a top of it, which may serve instead of the Caperuca; put the Pellet (or Mettle aforesaid) well kneaded together in Cakes of what form you please into the Vessel, and lest the Plate should melt and stick to the Iron Vessel, let it have a thin coat on the inside of Earthen ware; or such as Crusibles are made of, cover this Vessel with a large Limbeck head made of hammer'd Iron, or Copper, or of very good Earthen ware well glaz'd, and out of it draw a long Pipe a little sloping, the cavity whereof in the narrowest place, namely the extremity, than let be no lesser, the bigness of ones little finger, let the joyning of the Limbeck with the Vessel below it, be stopped very close with galt, then in a secure place that doth not feel the heat of the Furnace, let there be placed a great Vessel of stone or of other matter full of cold water, where-

whereinto let the nose of the Limbeck enter two fingers breadth, blow up the fire in the Furnace from which the Quicksilver flying in the form of vapor to the top of the Limbeck, the coolness whereof presently reduceth it into a body again, which runs down through the Nose into the Vessel of water aforesaid, the Limbeck should now and then be cooled on the outside with wet cloaths, and the water into which the Quicksilver falls as it becomes warm should have more fresh water added to it.

A. The deep Vessel of Iron, or Cooper.

B. The head of the Limbeck,

C. The Nose of it.

D. A Trevet.

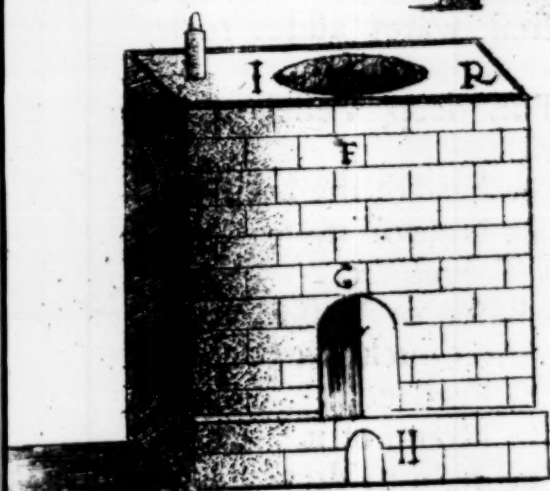
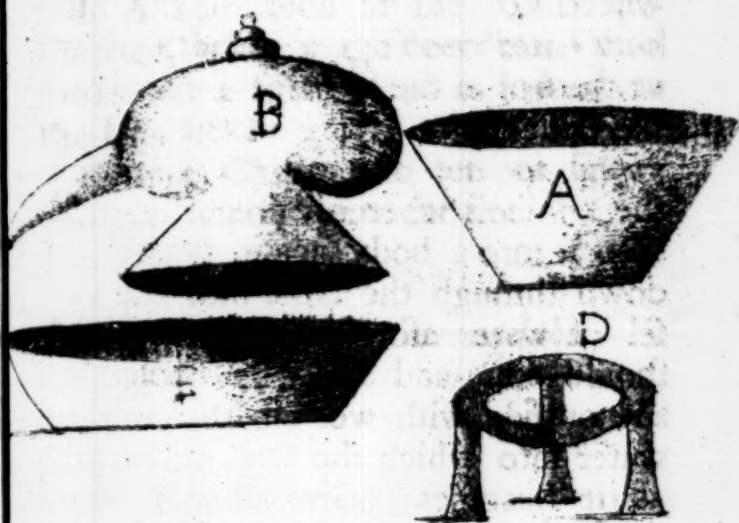
E. A Basen or Vessel of Water to receive the Quicksilver in.

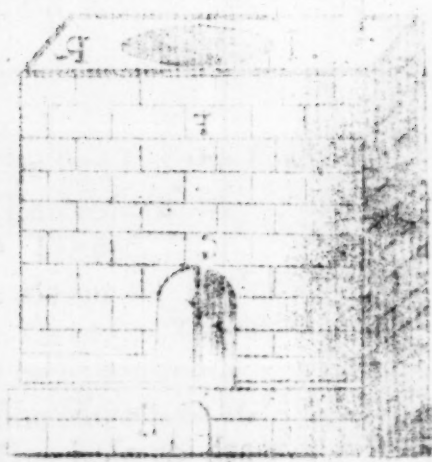
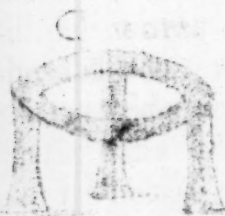
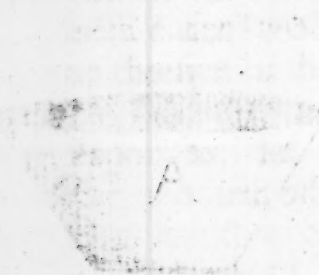
F. The Furnace.

G. The Mouth of it.

H. The hole to draw out the ashes at.

I. A





I. A hole open at the top of the Furnace, whereat the deep Iron Vessel looks out a little, and is joyned to the Limbeck.

K. Is a Chimney to let out smoak and give respiration to the fire.

Here place the Pictures and the Verses.

The

The trouble and hazard of keeping them close in the joynt with clay or galt, may be excused by making of the place where they shut one upon the other a handful and a half higher, or if to that size of them, that is now in use they put at the bottom on the outside, and fill it of two fingers broad; so that the lower Vessel may come up very close upon it, and cannot enter further into it, a little lower than the Caperucas come, are placed the Candlestick foot, as they call it, whereupon they set the Plate and the Pine Apple; the Candlestick foot comes up about four fingers higher than the mouth of the lower Vessel, which they call the Cannon in the which on the one side four or six fingers lower than the fire used to be, enters in a small Pipe of cold water at a hole made for that purpose in the Cannon without disturbing the Caperuca at all, because it is not to go in strait, but with a little liberty; over against this hole there is such another, out of which

which runs as much water as enters in at the former, whereby the Canon is always kept full, and the water in good temper to receive the Quicksilver without any prejudice.

If one separates the Quicksilver by the Limbeck, they may do the same thing, clapping a ring of Copper of two fingers breadth, and other two fingers deep to the mouth of the lower Vessel; so that the other Vessel may easily be let in and out, wherein the Quicksilver is to be saved. Into this Circle the Limbeck must be fitted, and to prevent its being blown off with the force of the vapor of the Quicksilver, the Limbeck must be kept down with weight on the top of it, or tying it to some other fixed thing, or making a ring on the top of the Limbeck pass a bar of Iron through it, both ends whereof afterward remaining fixed in two walls built on each side of it for that purpose.

F I N I S.

B.M.1950.